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(54) **METHODS AND APPARATUS FOR JOINT DISASSEMBLY**

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(58) **Field of Classification Search** 81/57.34, 81/69, 57.36, 64, 65.2, 68, 70, 65, 57.32
See application file for complete search history.

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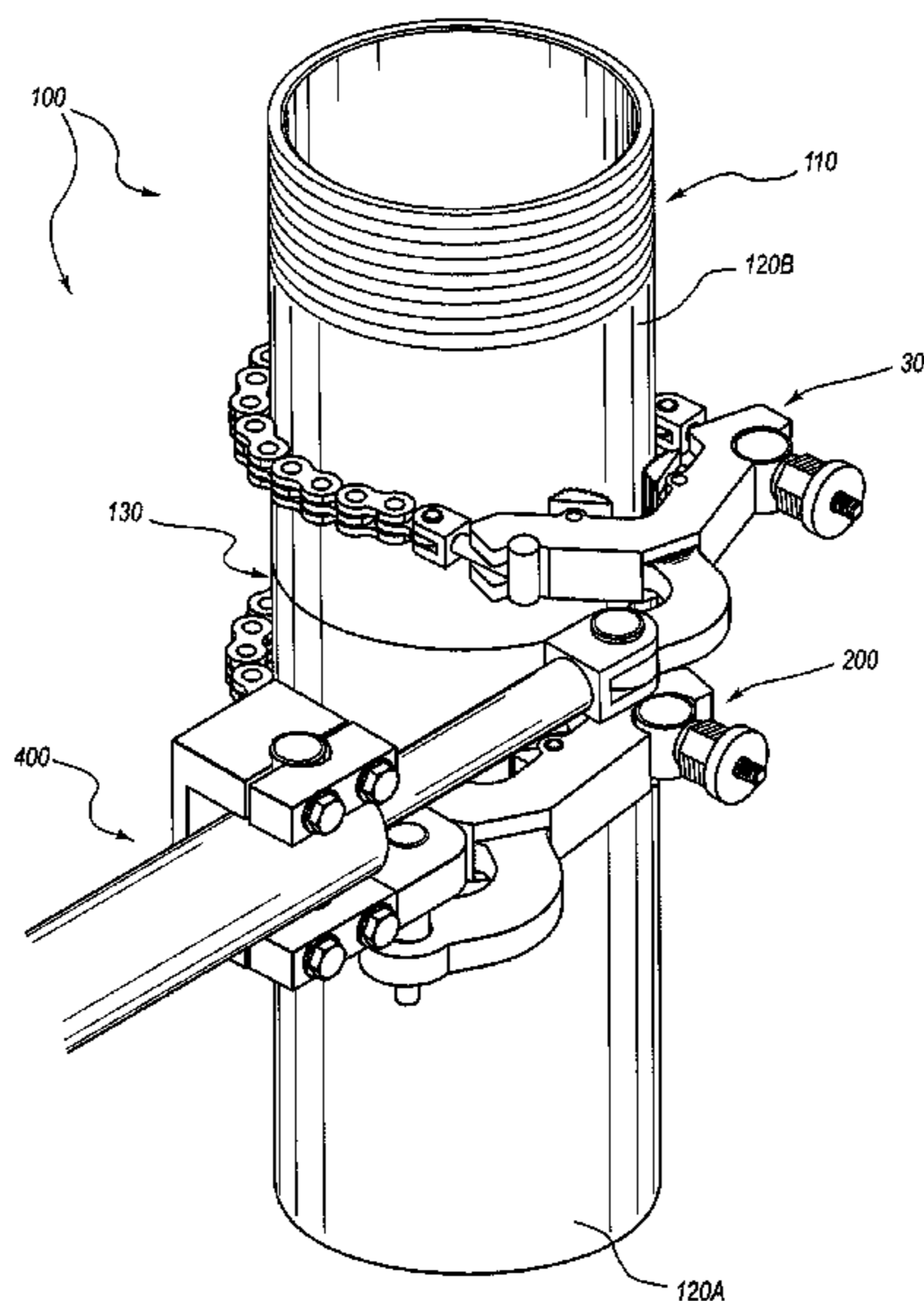
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(57) **ABSTRACT**

A joint tool includes a first wrench assembly configured to be placed in gripping contact with a rod, a second wrench assembly including jaws configured to grip and rotate a rod when the second wrench assembly is rotated in a first direction and to rotate relative to the rod when moved in a second direction, the second direction being opposite the first direction, and a drive assembly mounted to the first wrench assembly and coupled to the second wrench assembly, the drive assembly being configured to rotate the rod in the first direction and the second direction.

25 Claims, 9 Drawing Sheets



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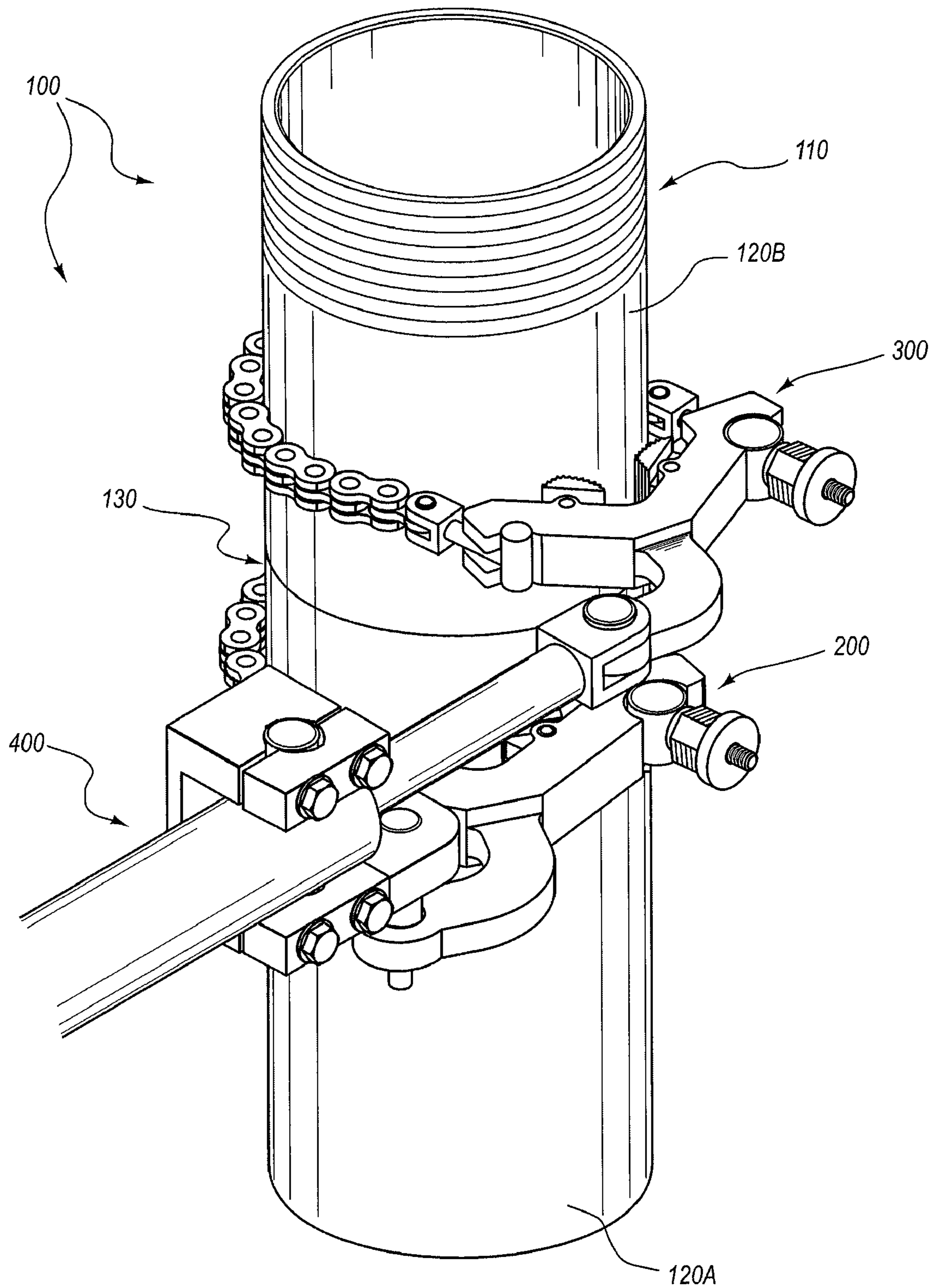


FIG. 1A

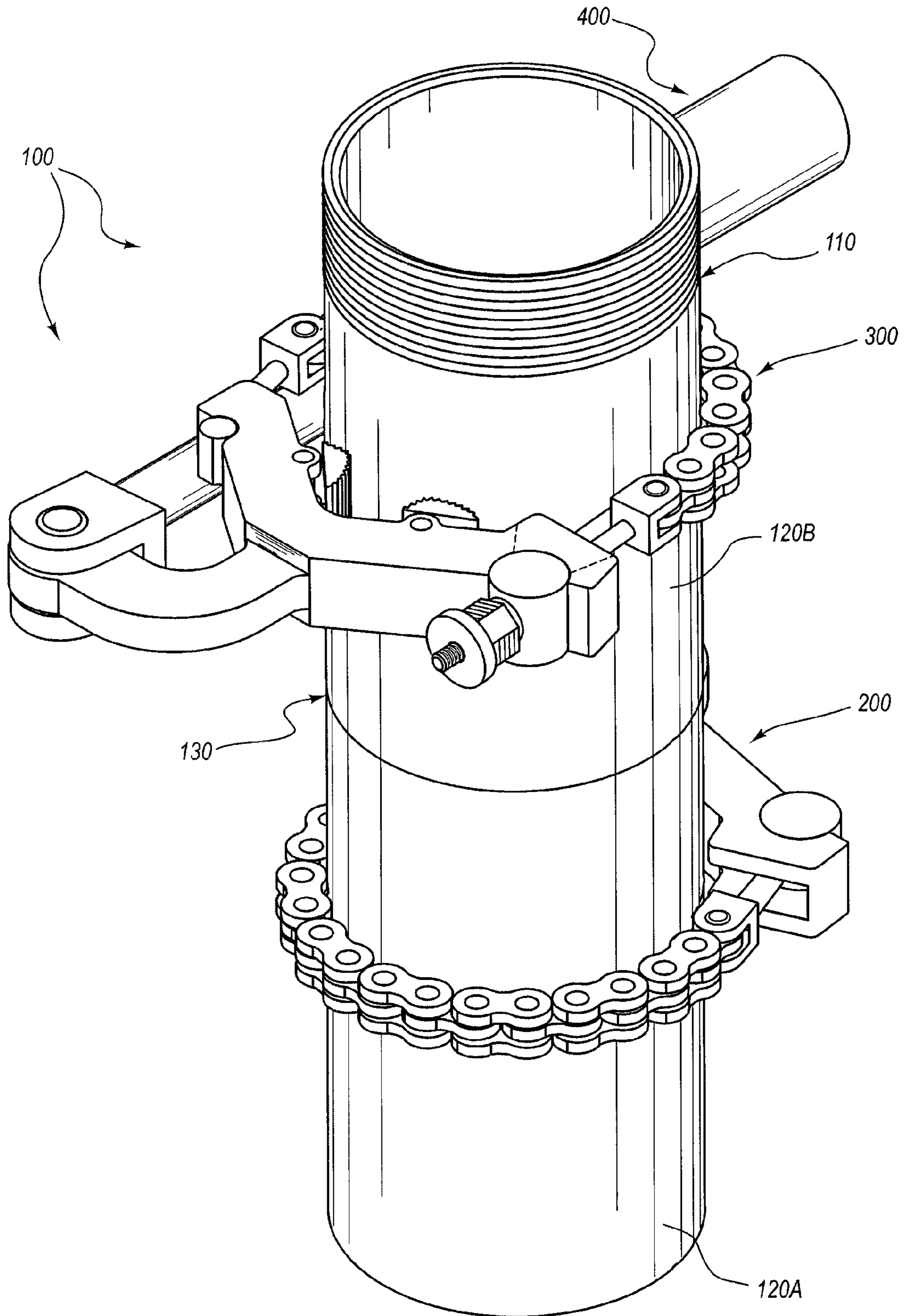


FIG. 1B

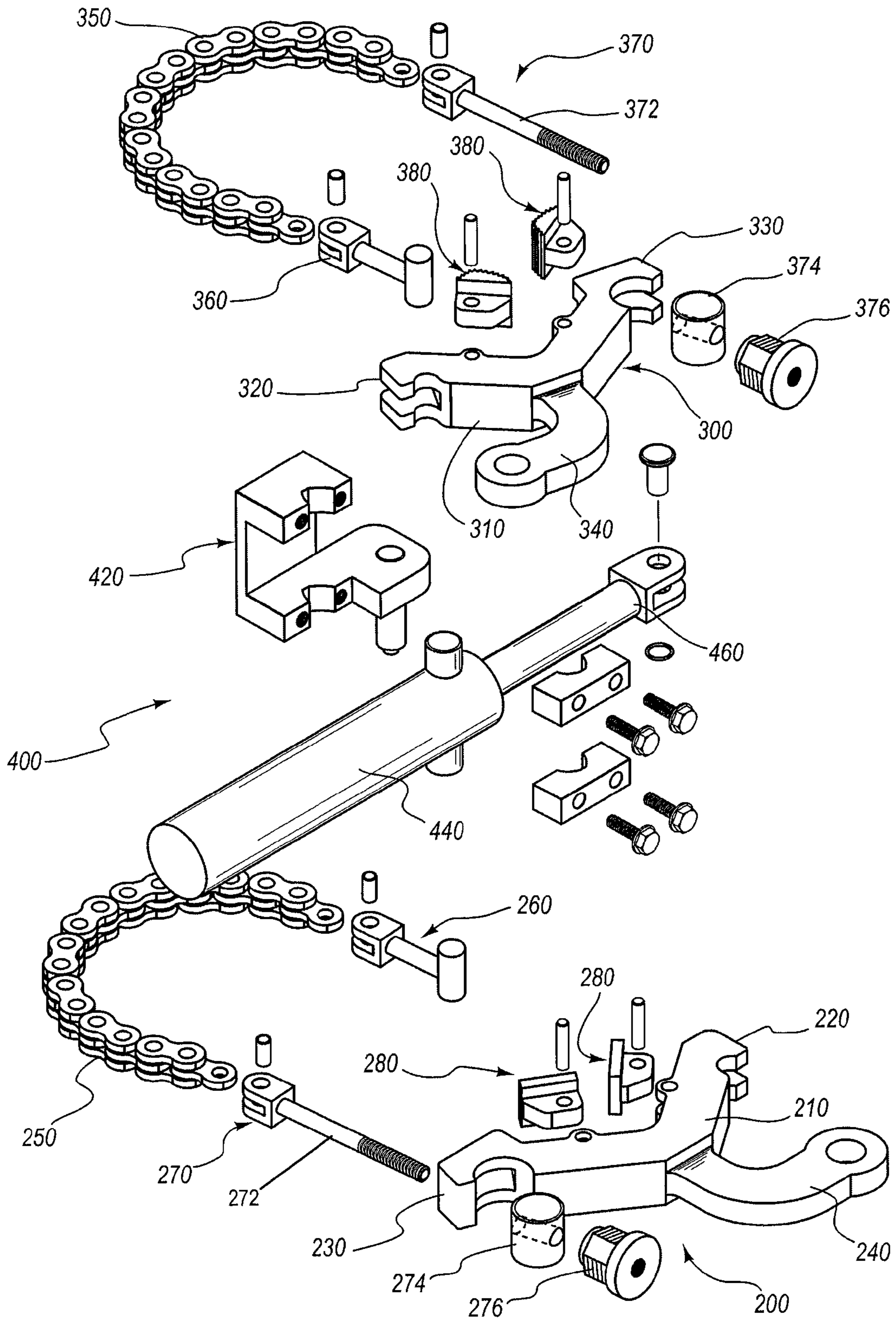


FIG. 1C

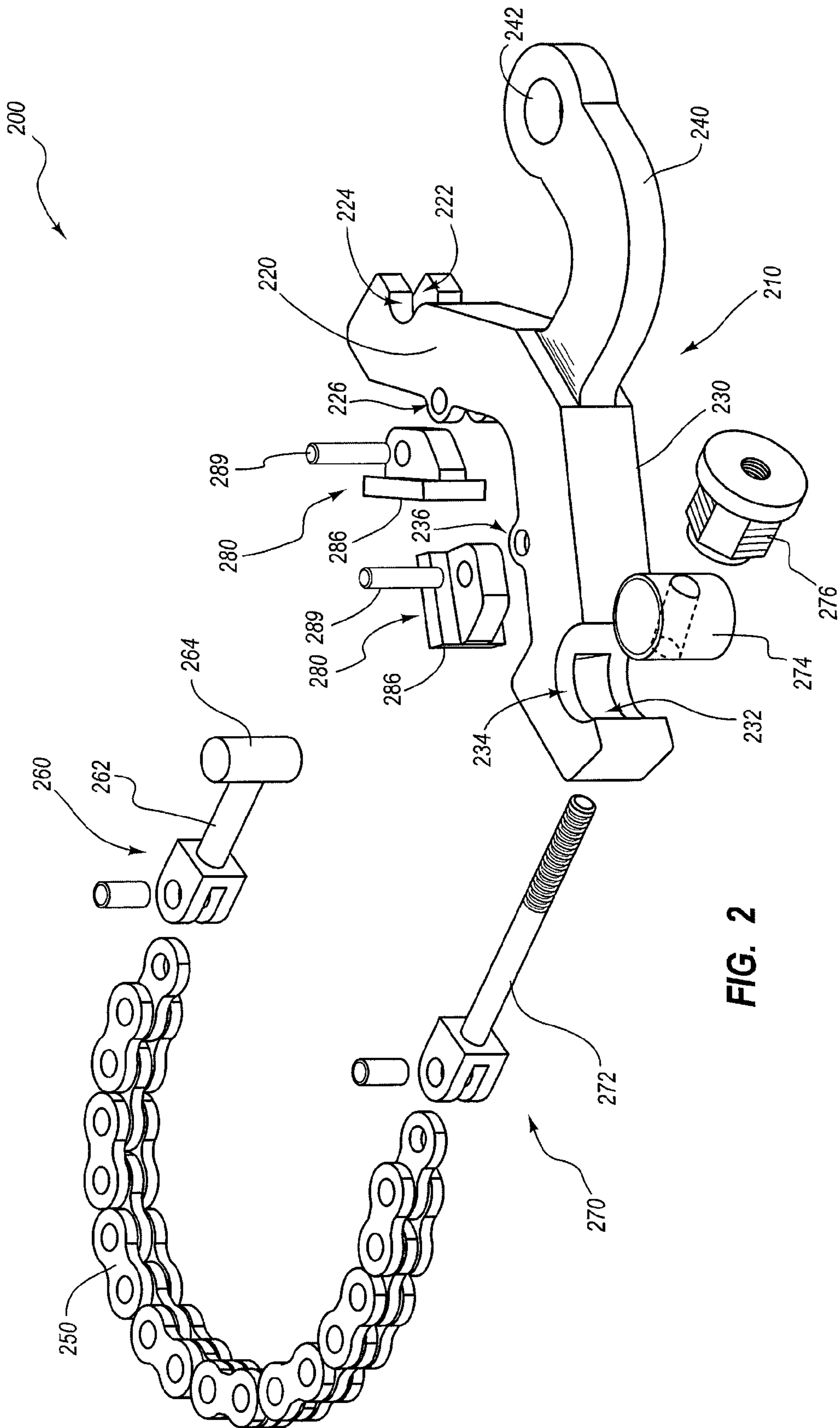


FIG. 2

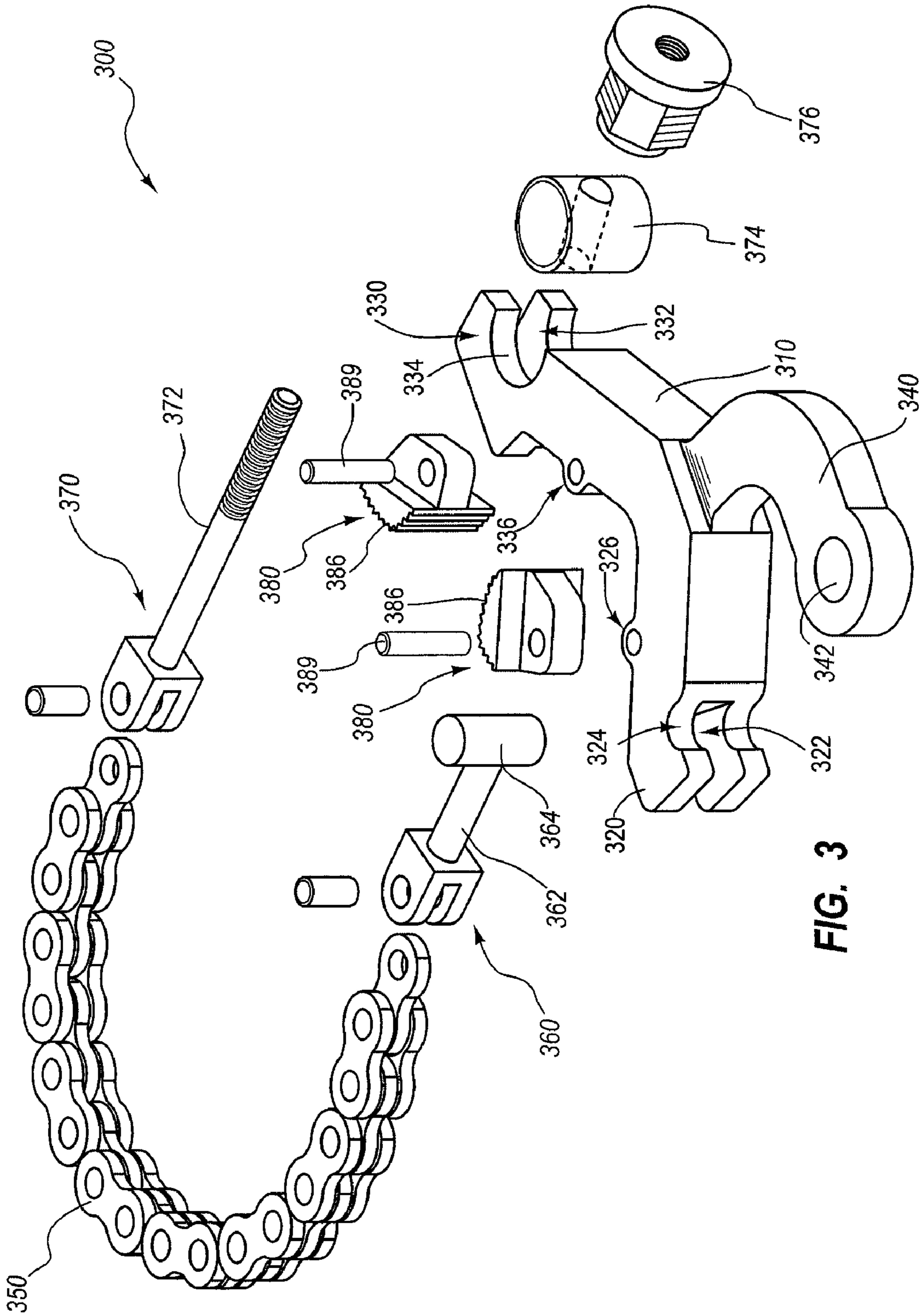


FIG. 3

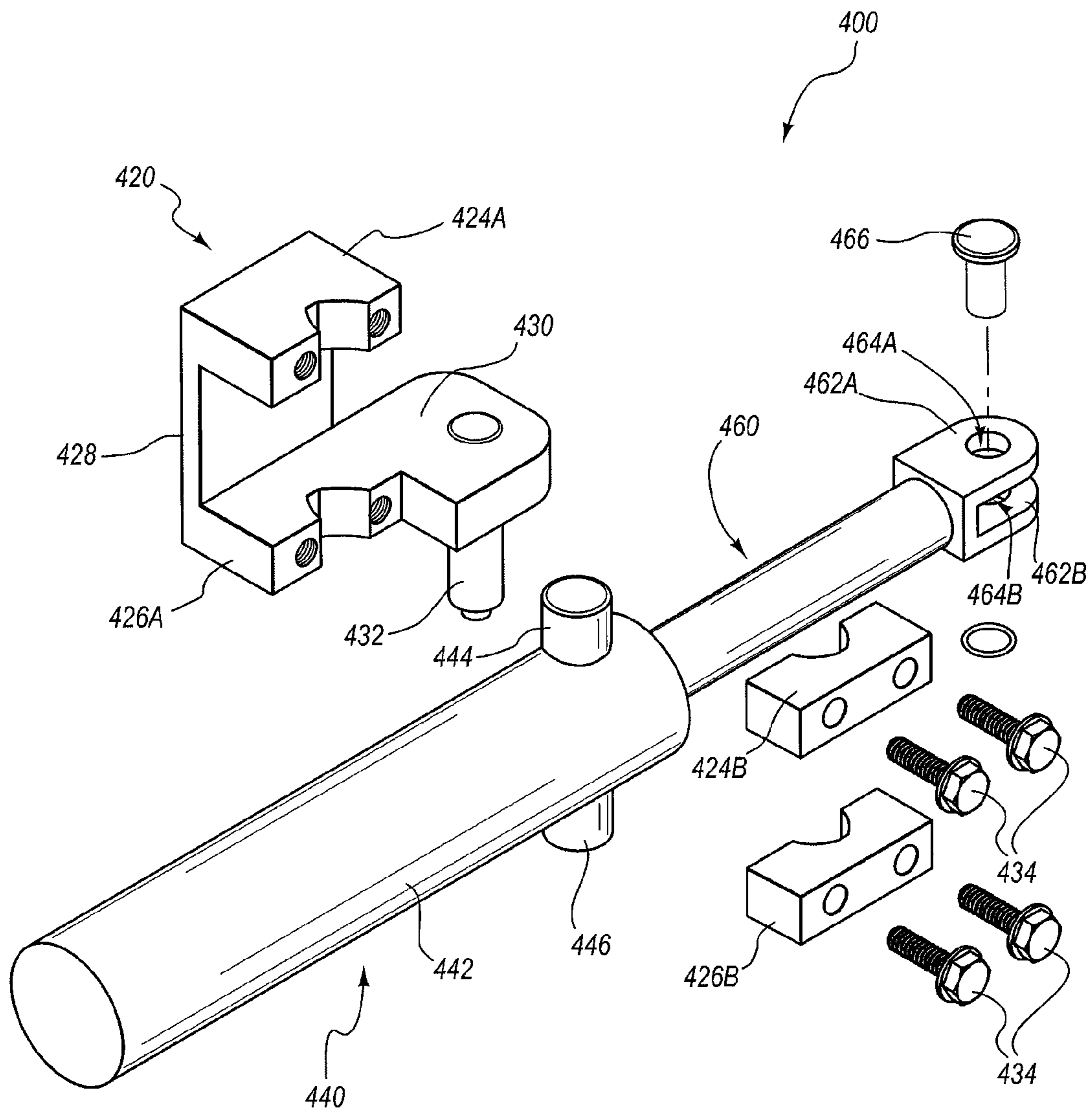
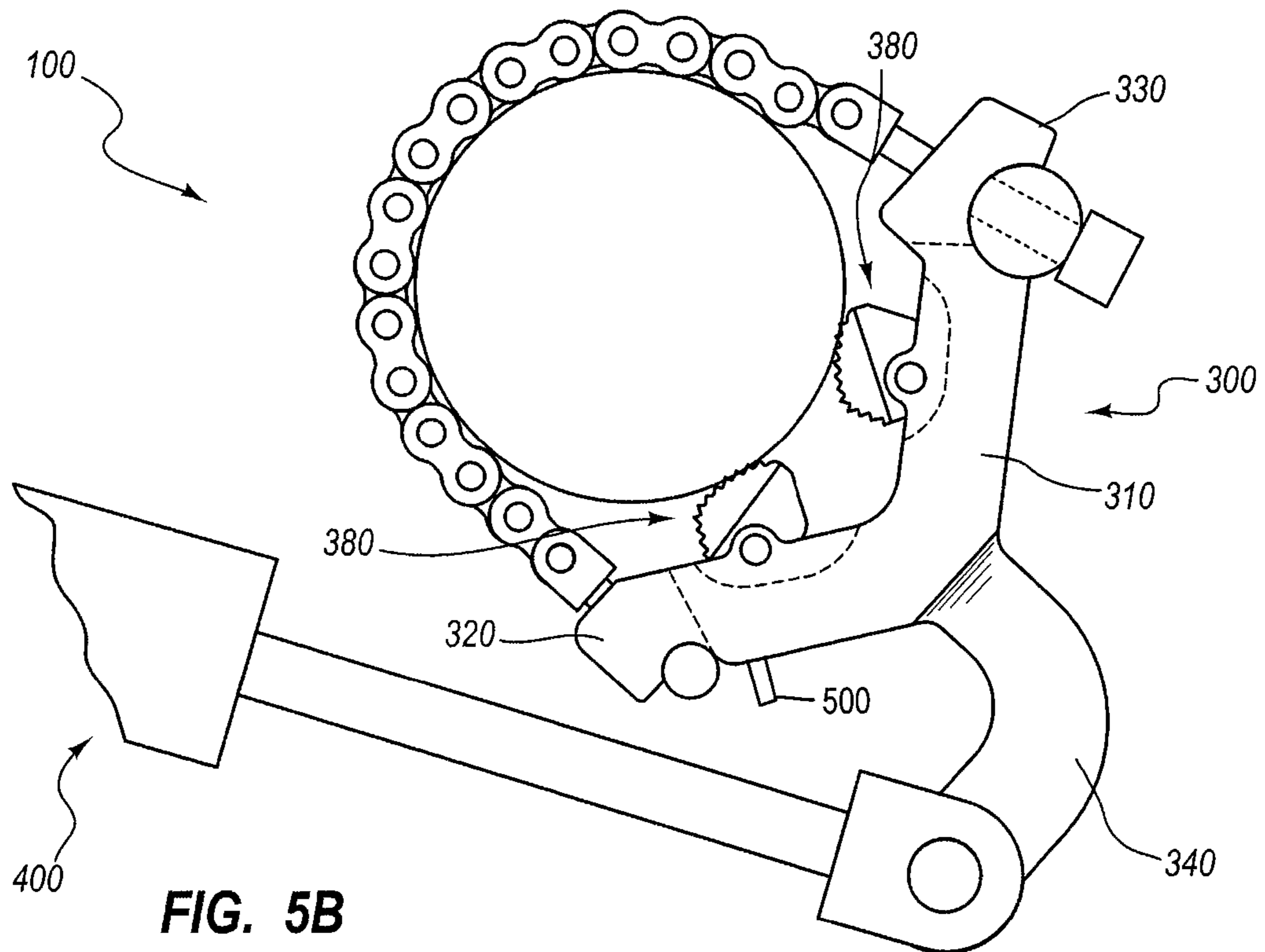
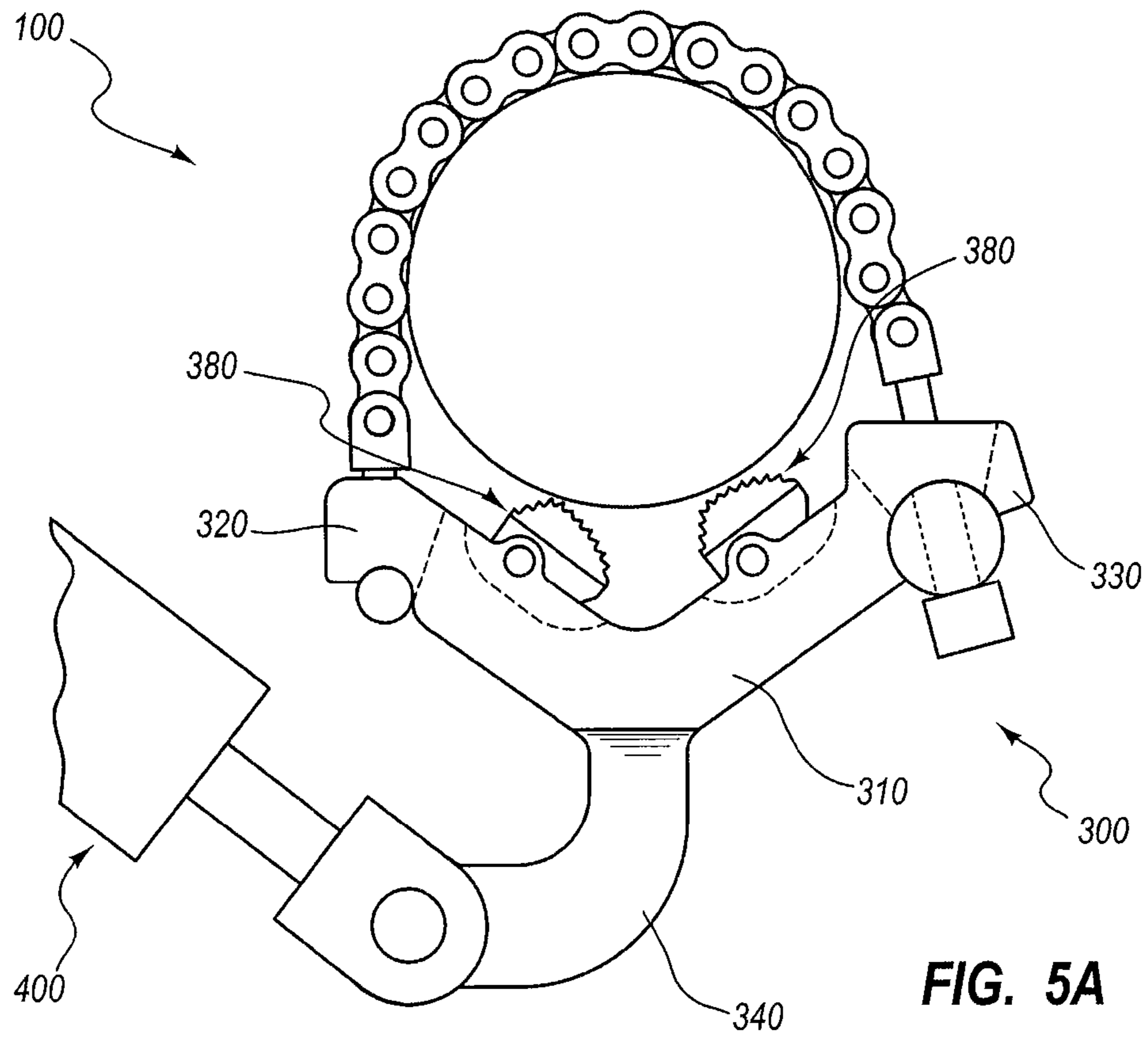


FIG. 4



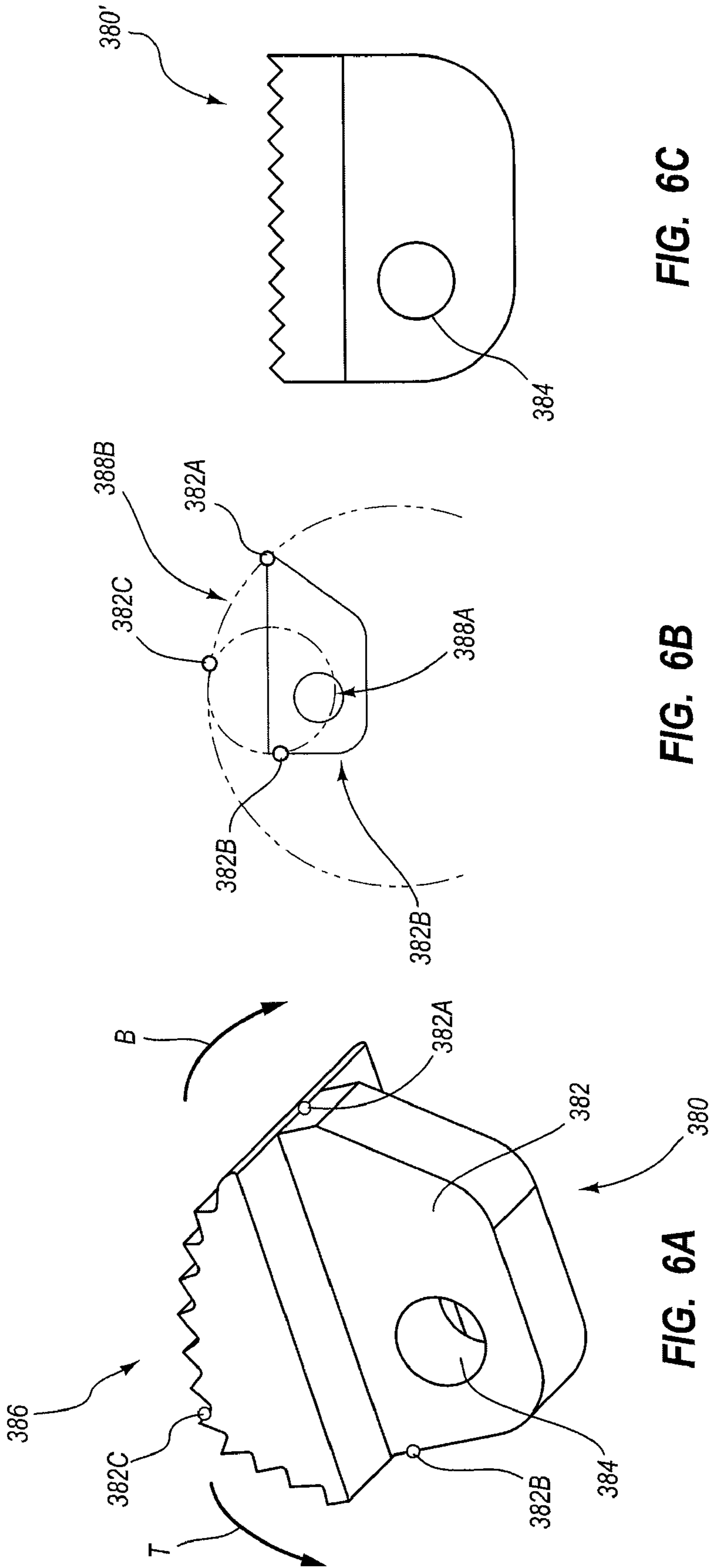


FIG. 6C

FIG. 6B

FIG. 6A

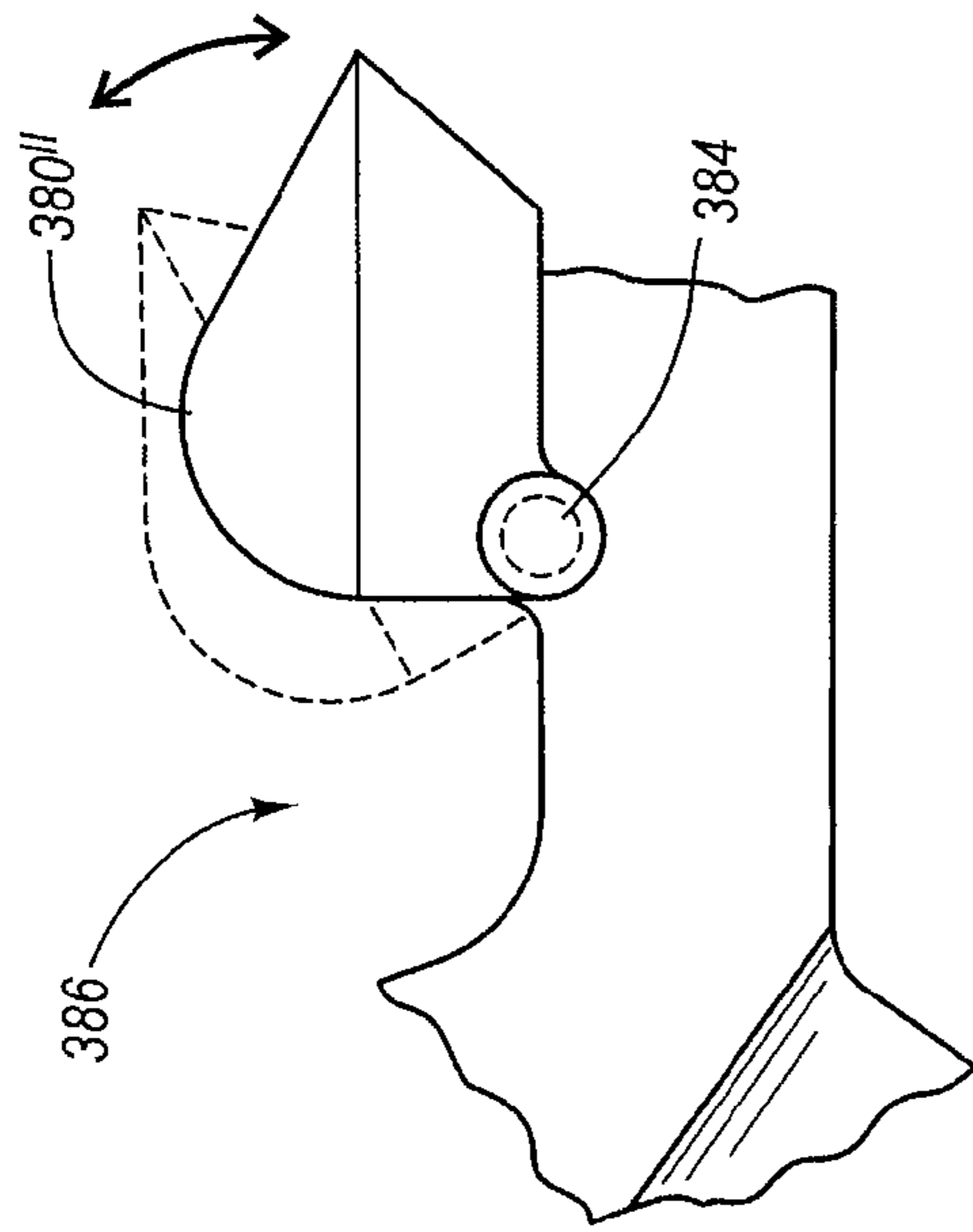


FIG. 6D

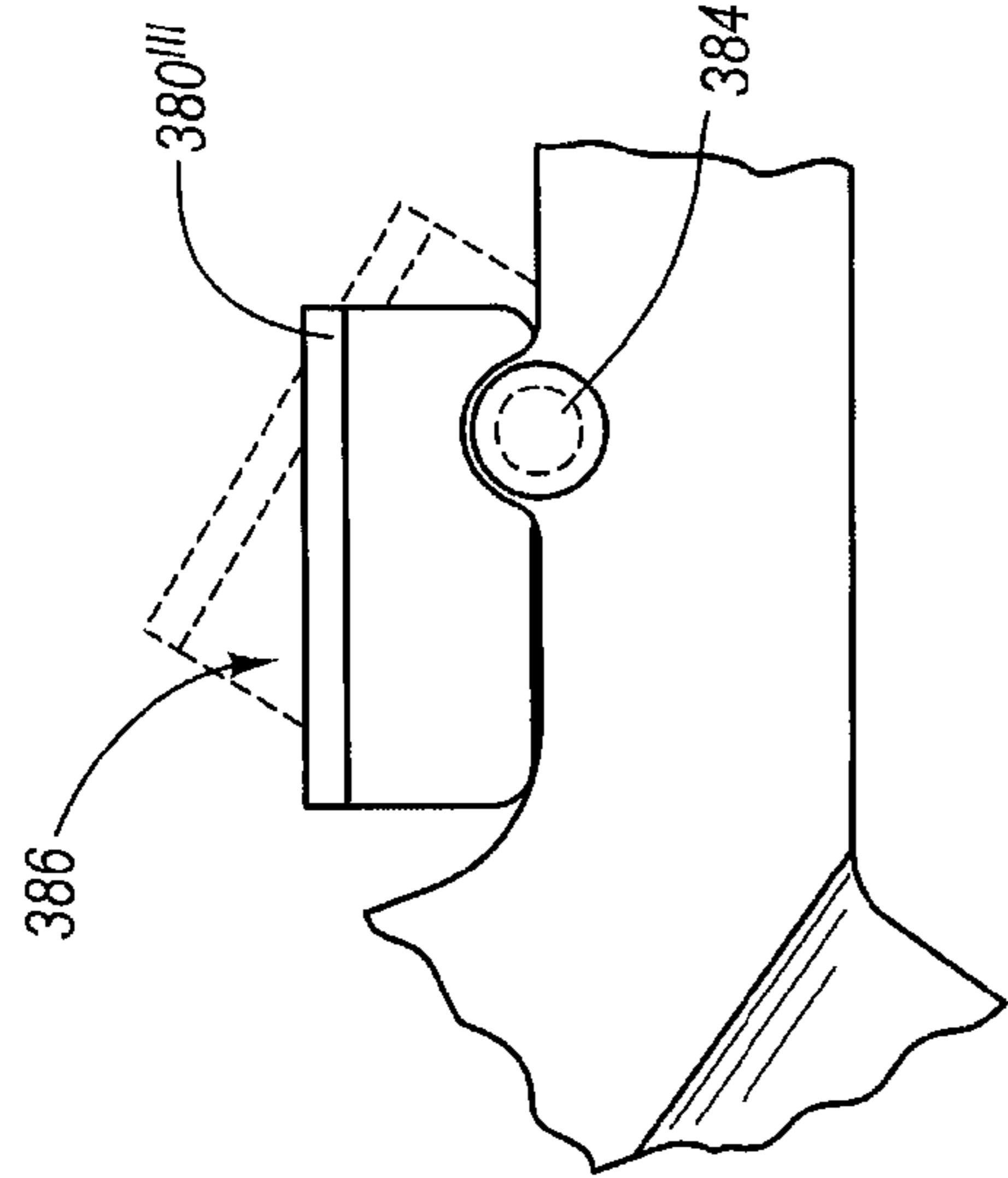


FIG. 6E

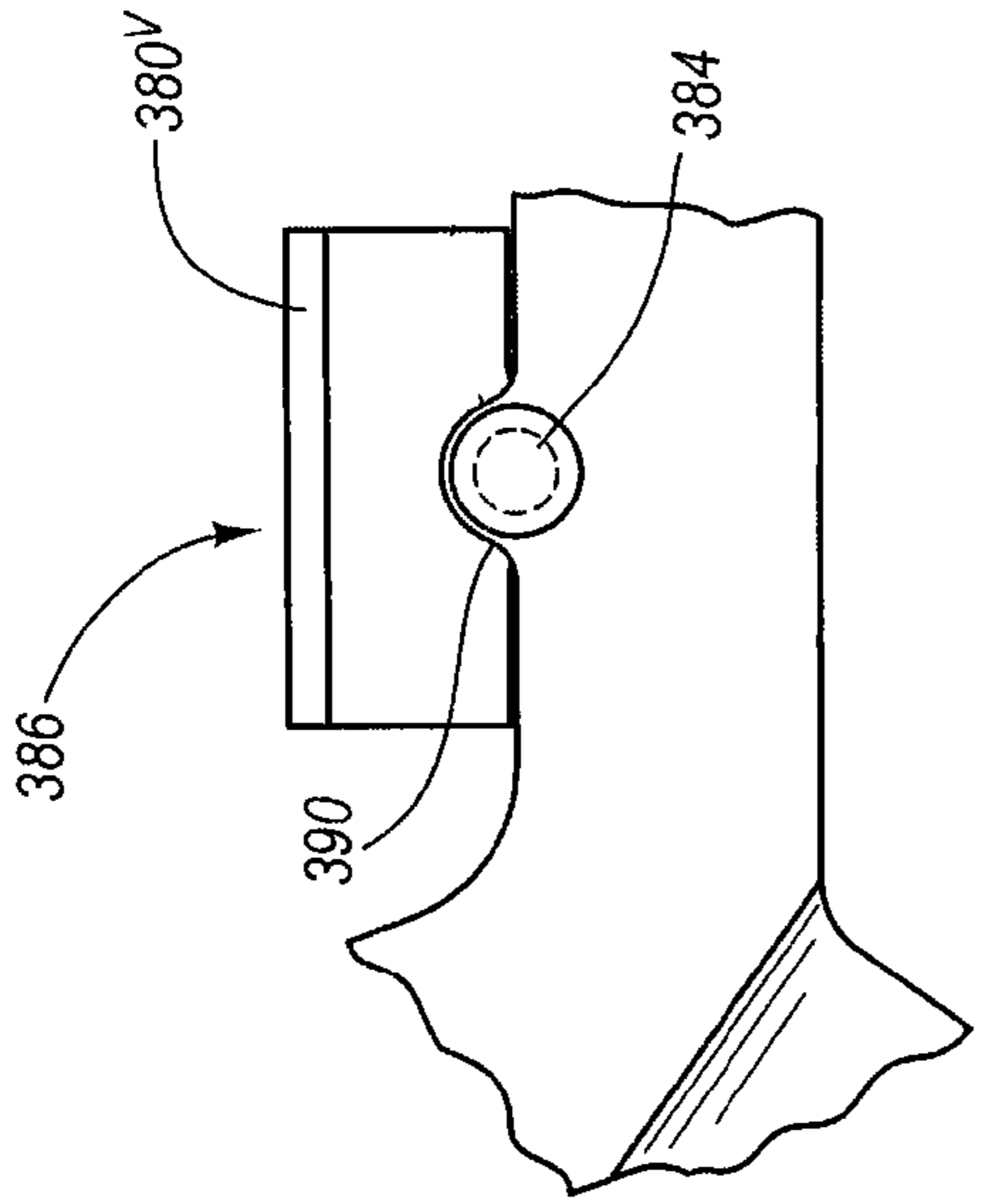


FIG. 7

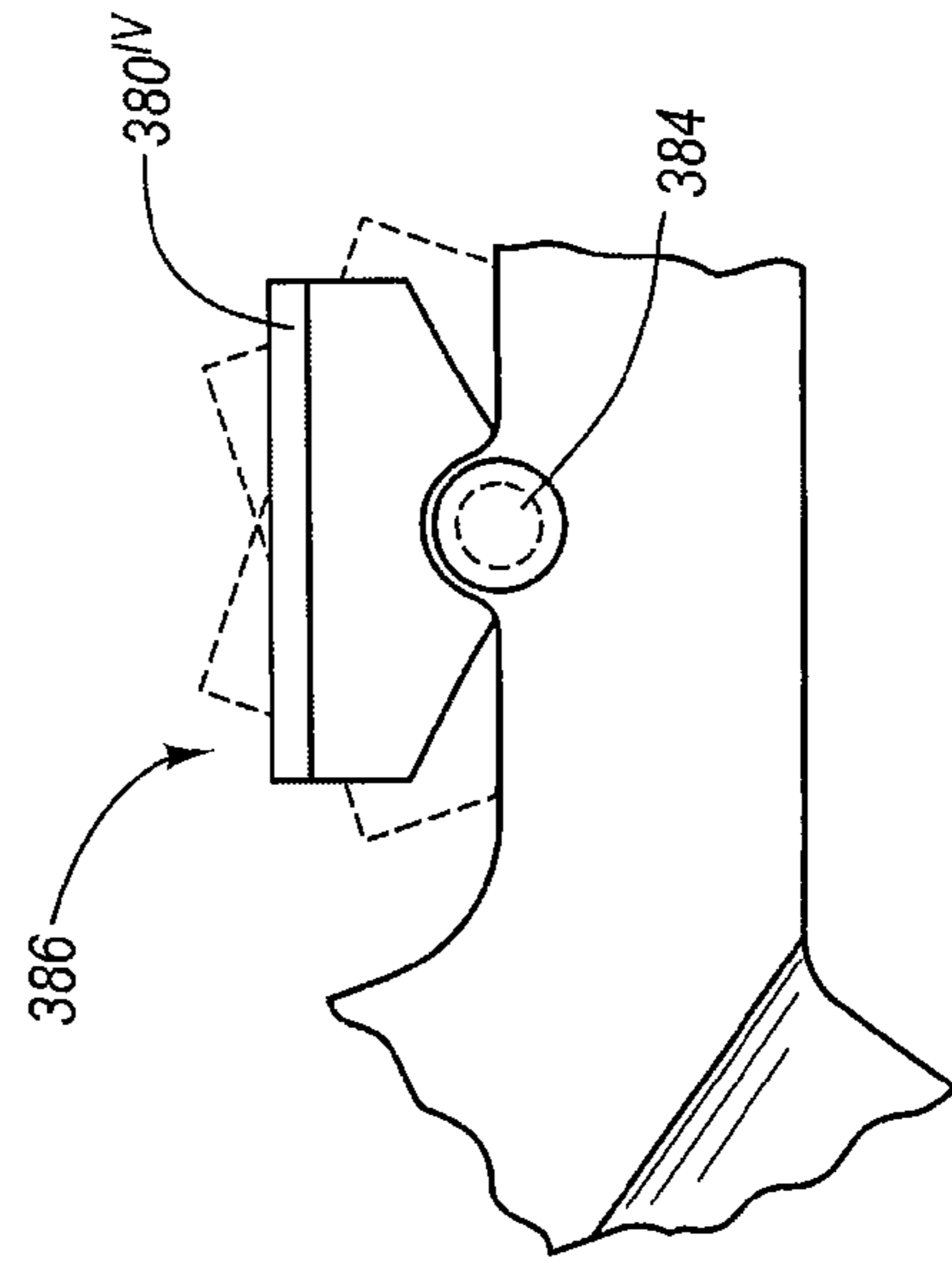


FIG. 6F

METHODS AND APPARATUS FOR JOINT DISASSEMBLY

RELATED APPLICATIONS

This application claims the benefit of U.S. Provisional Patent Application Ser. No. 60/944,163 filed Jun. 15, 2007, which is hereby incorporated by reference in its entirety.

FIELD

This application relates generally to apparatus for disassembling threaded joints, as well as methods for using such apparatus. In particular, this application relates to an apparatus for disassembling joints in pipes or rods, as well as methods for using such apparatus.

BACKGROUND OF THE INVENTION

The process of drilling, especially in subterranean formations, often involves lifting numerous sections of drill rod and/or casings into place and then connecting the sections together at the joints. The connected sections form a drill string, which is often tipped with a drill bit. Frequently, the joints on the drill rods or casings include male and female threads that may be connected together. During the drilling process, a drill rig applies an axial force and rotates the drill string, often causing these joints to become very tight.

Generally, if the drill string is removed from the borehole (the hole created during drilling) for any reason (e.g., to replace or repair the drill bit), the entire string of drill rods may need to be removed by tripping it out of the borehole, section by section. As this is done, each of the joints for the rods, which now may be extremely tight, may have to be broken and the male and female ends of adjacent rods may need to be separated. In some instances, multiple drill rod sections, which are typically around 5, 10, or 20 feet, may be connected to form a string that extends for very long distances. Thus, a single drill string may have hundreds of joints that may need to be broken and separated.

In many instances, in order to break the joint, the joint is positioned to place the joint near a foot clamp that is located near the bottom of the rig. The foot clamp then clamps the rod while large mechanisms powered by the rig break the joint. In some instances, however, it may be difficult or impractical to position the joint near the foot clamp portion of the drill rig.

Currently, to break and unscrew a joint that is not positioned within the envelope of the foot clamp, several conventional methods are used. First, if possible, the joint can be broken manually using a rigid pipe wrench to break the joint. Second, breaking of the joint may be aided by the power of the rig, using a rigid pipe wrench that is optionally secured against flying off in the event of a failure. And finally, the joint may be broken using whatever it takes to break the joint, i.e., snipes, come-alongs, chain blocks, etc. Such processes may be slow, time consuming, dangerous, and costly because of the cost of labor and the lost opportunity cost.

BRIEF SUMMARY OF THE INVENTION

In at least one example, a joint tool includes a first wrench assembly configured to be placed in gripping contact with a rod. The joint tool also includes a second wrench assembly including jaws configured to grip and rotate the rod when the second wrench assembly is moved in a first direction and to rotate relative to the rod when the second wrench assembly is moved in a second direction that is opposite the first direction.

The joint tool further includes a drive assembly mounted to the first wrench assembly and coupled to the second wrench assembly. The drive assembly is configured to rotate the rod in the first direction and the second direction.

A joint tool may also include a fixed wrench assembly configured to be grippingly secured to a rod, a drive assembly coupled to the fixed wrench assembly, and a floating wrench assembly configured to be coupled to the drive assembly. The floating wrench assembly includes a wrench body, a fetter, and at least one coupler coupling the fetter to the wrench body. The floating wrench assembly may further include at least one jaw configured to grip and rotate the rod when the floating wrench assembly is rotated in the first direction and to slip relative to the rod when the floating wrench assembly is rotated in a second direction that is opposite the first direction. The drive assembly is configured to be mounted to the fixed wrench assembly and coupled to the floating wrench assembly to thereby move the floating wrench assembly in the first direction and the second direction.

A method of breaking a joint between a first rod and a second rod is provided that includes placing a fixed wrench assembly into gripping contact with the first rod on a first side of the joint, mounting a drive assembly to the fixed wrench assembly, coupling a floating wrench assembly to the drive assembly, and placing the floating wrench assembly into engagement with a second rod on a second side of the joint that is opposite the first side. The floating wrench assembly is configured to grip and rotate the second rod when rotated in a first direction and to slip over the second rod when rotated in a second direction that is opposite the first direction. The drive assembly may then be actuated to rotate the floating wrench in the first direction.

BRIEF DESCRIPTION OF THE DRAWINGS

The following description can be better understood in light of the following Figures, in which:

FIG. 1A is a perspective view of a joint tool according to one example;

FIG. 1B illustrates an alternative perspective view of the joint tool of FIG. 1A;

FIG. 1C illustrates an exploded view of the joint tool of FIG. 1A;

FIG. 2 illustrates an exploded view of a fixed wrench assembly according to one example;

FIG. 3 illustrates an exploded view of a floating wrench assembly according to one example;

FIG. 4 illustrates an exploded view of a drive assembly according to one example;

FIG. 5A is a top view of a joint tool according to one example;

FIG. 5B is a top view of a joint tool according to one example;

FIG. 6A illustrates a jaw according to one example;

FIG. 6B illustrates a jaw according to one example;

FIG. 6C illustrates a jaw according to one example;

FIG. 6D illustrates a jaw according to one example;

FIG. 6E illustrates a jaw according to one example;

FIG. 6F illustrates a jaw according to one example; and

FIG. 7 illustrates a jaw according to one example.

Together with the following description, the Figures demonstrate and explain the principles of the apparatus and methods for using the apparatus. In the Figures, the thickness and configuration of components may be exaggerated for clarity.

The same reference numerals in different Figures represent similar, though not necessarily identical, components.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

A joint tool is provided herein that is configured to break joints between various components of a drill string. Methods are also provided for breaking joints. For ease of reference, joints between rods will be described below. In at least one example, the joint tool includes three assemblies: a fixed wrench assembly, a floating wrench assembly, and a drive assembly. The fixed wrench assembly may be located on one side of a joint. The drive assembly can then be mounted to the fixed wrench assembly. The floating wrench assembly can then be coupled to the drive assembly and then to an opposite side of the joint as the fixed wrench assembly. At least the floating wrench assembly includes jaws that grip a rod as it rotates in a first direction, sometimes referred to as a breaking direction. The jaws slip past the rod as the jaws rotate in the opposite or second direction. The drive assembly is configured to move the floating wrench assembly in the first direction such that the floating wrench assembly grips the rod and rotates the rod relative to the fixed wrench assembly to thereby break the joint.

The configuration described above may allow the joint tool to be readily portable and quickly installed. Further, the configuration of the floating wrench assembly may allow the joint tool to not only break a joint, but to unthread the joint as well by reciprocating movement of the floating wrench assembly. Portability and ease of installation of the joint tool may increase the productivity of a drill rig by reducing the time associated with breaking joints and/or unthreading rods or other drill string components.

The following description supplies specific details in order to provide a thorough understanding. Nevertheless, the skilled artisan would understand that the apparatus and associated methods of using the apparatus may be implemented and used without employing these specific details. Indeed, the apparatus and associated methods can be placed into practice by modifying the illustrated apparatus and associated methods and can be used in conjunction with any apparatus and techniques conventionally used in the industry. For example, while the description below focuses on joint tools for breaking and/or making drill rod joints; this apparatus may be implemented in many other applications, such as connecting and/or disconnecting any two tubular or cylindrical objects by twisting one of the objects relative to the other. Examples of such tubular or cylindrical objects include: piping, such as household piping or industrial piping; bits; rods, such as casing rods; reaming shells; water swivels; core barrel components; down-hole tools; and so forth. Accordingly, the description of a rod will be understood to be equally applicable to such tubular or cylindrical objects.

FIGS. 1A-1C illustrates an apparatus for joint disassembly, hereinafter referred to as a joint tool **100**. As illustrated in FIGS. 1A-1C, the joint tool **100** generally includes opposing wrench assemblies. In the illustrated example, the opposing wrench assemblies include a fixed wrench assembly **200** and a floating wrench assembly **300**. In the illustrated example, a drive assembly **400** is mounted to the fixed wrench assembly **200**. The floating wrench assembly **300** is further coupled to the drive assembly **400**.

The joint tool **100** is configured to break a joint between connected elongate members, such as components of a drill string **110**. In the illustrated example, the drill string **110** includes a first drill rod **120A** and a second drill rod **120B** that

are secured together at a joint **130**. One exemplary method of breaking a joint with the joint tool **100** will first be introduced. While one method is described, it will be appreciated that the steps may be performed in any order, some steps may be omitted, and additional steps may be performed to break a joint with a joint tool **100**.

In order to break the joint **130**, the fixed wrench assembly **200** may first be secured to the first drill rod **120A**. The fixed wrench assembly **200** may be secured to the first drill rod **120A** in such a manner as to minimize rotation of the fixed wrench assembly **200** relative to the second drill rod **120A**. Coupling the fixed wrench assembly **200** to the first drill rod **120A** in such a manner as to reduce or eliminate relative rotation between the fixed wrench assembly **200** and the first drill rod **120A** may be referred to as gripping.

After the fixed wrench assembly **200** has been moved into gripping engagement with the first drill rod **120A**, the drive assembly **400** may then be secured or mounted to the fixed wrench assembly **200**. In at least one example, the driving assembly **400** may be secured to the fixed wrench assembly **200** in such a manner as to minimize rotation between the fixed wrench assembly and the drive assembly **400**. In other examples, the drive assembly **400** may be coupled to the fixed wrench assembly **200** in a manner to allow any degree of rotation between the fixed wrench assembly **200** and the drive assembly **400** as desired.

Once the drive assembly **400** has been secured to the fixed wrench assembly **200**, the floating wrench assembly **300** can then be secured to the drive assembly **400** in such a manner as to locate the floating wrench assembly **300** on the opposite side of the joint **130** as the fixed wrench assembly **200**. This location may bring the floating wrench assembly **300** into initial engagement with the second drill rod **120B**. The engagement may include coupling the floating wrench assembly **300** to the second drill rod **120B** in such a manner that there is sufficient tension between the floating wrench assembly **300** and second drill rod **120B** to maintain contact between the two but less tension than would cause the floating wrench assembly **300** to grip the second drill rod **120B**. Accordingly, such engagement may allow for some initial rotation between the floating wrench assembly **300** and the second drill rod **120B**.

The drive assembly **400** may then be actuated to break the joint **130**. In at least one example, the power to actuate the drive assembly **400** may be provided by a portable pack or by an auxiliary power pack on a drill rig. Actuation of the drive assembly **400** may be used to cause the floating wrench assembly **300** to grip the second drill rod **120B**. For ease of reference, the drive assembly **400** will be described as moving between a retracted position and an extended position. As the drive assembly **400** moves toward the extended position, the drive assembly **400** causes the floating wrench assembly **300** to grip and rotate the second drill rod **120B** in a first direction. The first direction may also be referred to as a breaking direction, which may be a counterclockwise rotation.

In at least one example, the floating wrench assembly **300** includes jaws that come into initial contact with the second drill rod **120B** when the floating wrench assembly **300** engages the second drill rod **120B** as described above. Rotation of the floating wrench assembly **300** in the breaking direction by the drive assembly **400** causes the jaws to move in such a manner as to cause gripping contact between the floating wrench assembly **300** and the second drill rod **120B**. This gripping contact may be maintained as the drive assembly **400** further rotates the floating wrench assembly **300** in the breaking direction to thereby rotate the second drill rod **120B**.

Once the drive assembly **400** has reached a fully extended position, the drive assembly **400** may be moved toward a retracted position. In at least one example, as the drive assembly **400** moves toward the retracted position, the drive assembly **400** rotates the floating wrench assembly **300** in a second or tightening direction that is opposing the breaking direction.

Rotation of the floating wrench assembly **300** in the tightening direction may result in movement of the jaws associated with the floating wrench assembly **300** that causes the jaws to move out of gripping contact with the second drill rod **120B**, which in turn allows the floating wrench assembly **300** to rotate relative to the second drill rod **120B**. The drive assembly **400** may then be extended again to cause the floating wrench assembly **300** to grip and rotate the drill rod **120B** as the floating wrench assembly **300** rotates in the breaking direction. This process may be repeated as desired to unthread the second drill rod **120B** from the first drill rod **120A**. Accordingly, breaking and unthreading may be accomplished by a single joint tool.

In at least one example discussed herein, the fixed wrench assembly can include a wrench body and a fetter that is secured to the wrench body by one or more couplers. Further, the floating wrench assembly can also include a fetter secured to a wrench body by one or more couplers. Further, in at least one of the examples discussed below, the drive assembly is configured to extend in a generally linear fashion to cause rotation of the floating wrench assembly. In at least one of such examples, the rotation of the floating wrench assembly causes the gripping contact with a rod described above.

One exemplary configuration of a joint tool **100** will now be discussed in further detail with reference to FIG. 1C. The fixed wrench assembly **200** illustrated in FIG. 1C generally includes a wrench body **210** having a first engagement arm **220**, a second engagement arm **230**, and a lever arm **240**. A fetter **250** may be removably coupled to the wrench body **210** by one or more couplers, such as a first coupler **260** and a second coupler **270**. The first coupler **260** and the second coupler **270** may be configured to allow the fetter **250** to be rapidly secured to and/or removed from the wrench body **210**. Further, fetters of varying lengths may be interchanged as desired. Interchanging fetters of varying lengths allows the wrench body **210** to break joints in rods of varying diameters.

As illustrated in FIG. 1C, the floating wrench assembly **300** may be similar to the fixed wrench assembly **200**. Accordingly, the floating wrench assembly **300** generally includes a wrench body **310** having a first engagement arm **320**, a second engagement arm **330**, and a lever arm **340**. A fetter **350** may be removably coupled to the wrench body **310** by one or more couplers, such as a first coupler **360** and a second coupler **370**.

The drive assembly **400** generally includes a mount **420**, a cylinder **440** secured to the mount **420**, and a rod **460** operatively associated with the cylinder **440**. In the illustrated example, the fixed wrench assembly **200** is coupled to mount **420** while the floating wrench assembly **300** is coupled to the rod **460**. Additional details regarding the exemplary fixed wrench assembly **200** will be discussed with reference to FIG. 2, regarding the floating wrench assembly **300** will be discussed with reference to FIG. 3, and regarding the drive assembly **460** will be described in more detail with reference to FIG. 4.

As previously introduced, the fixed wrench assembly **200** generally includes the wrench body **210** and the fetter **250**. The wrench body can have any desired shape and any number of engagement arms. In the example illustrated in FIG. 2, the first engagement arm **220** and the second engagement arm **230** define a span as they form a broad V-shape. In other

examples, the first engagement arm **220** and second engagement arm **230** form other shapes as they defined a span.

The wrench body **210** may be of any desired size and thus may be designed for use on rods of various sizes. For example, the first engagement arm **220** and the second engagement arm **230** may span about 0.5 inches to about 60 inches. Accordingly, the fixed wrench assembly **200** may be used on rods of varying sizes, such on pipes as small as household pipes to large industrial piping. In some instances, though, the wrench body **210** may span almost seven and a half inches between the first engagement arm **220** and the second engagement arm **230**.

FIG. 2 further illustrates that the fetter **250** can be removably coupled to the first engagement arm **220** by the first coupler **260** and to the second engagement arm **230** by the second coupler **270**. In particular, the first engagement arm **220** may include a channel **222** defined therein that is in communication with a recess **224**. The first coupler **260** in turn may include a transverse member **262** that is configured to enter the channel **222** as well as extend therethrough. The first coupler **260** further includes a pivot pin **264** secured to the transverse member **262**. The pivot pin **264** is configured to engage the recess **224** in such a manner that may allow the first coupler **260** to pivot relative to the first engagement arm **220** while the two are engaged.

The second coupler **270** can also be configured to be coupled to the second engagement arm **230** in such a manner that the second coupler **270** is able to rotate relative to the second engagement arm **230** while the two are engaged. In particular, the second engagement arm **230** may include a hole **232** defined therein that is in communication with a recess **234**. The second coupler **270** in turn may include a threaded rod **272**, a swivel **274**, and a nut **276**. The threaded rod **272** may be configured to pass through the hole **232** and through the swivel **274**. The swivel **274** in turn may be sized to engage the second engagement arm **230** at the recess **234**.

The nut **276** may then be screwed on to the threaded rod **272** to thereby maintain the swivel **274** in engagement with the second engagement arm **230** at the recess **234**. As the nut **276** is further threaded onto the threaded rod **272**, the threaded rod **272** advances through the nut **276** thereby drawing the fetter **250** closer to the second engagement arm **230**.

If a rod is located between the fetter **250** and the wrench body **210**, drawing the fetter **250** toward the second engagement arm **230** can tension the fixed wrench assembly **200** to the rod. In at least one example, the nut **276** may be configured to be tensioned in such a manner as to rigidly secure the fixed wrench assembly **200** to the rod. In such an example, the nut **276** may be of a shape and/or size to allow a wrench or other tightening device to engage the nut **276**. In other examples, the nut be sized and/or shaped to be tightened by hand or by any other method to tighten the fixed wrench assembly **200** to a rod.

Accordingly, the fixed wrench assembly **200** is configured to be secured to joints having a wide range of diameters. As previously introduced, the fixed wrench assembly **200** is further configured to have a drive assembly **400** (FIGS. 1A-1C, FIG. 4) coupled thereto. In one example, the drive assembly **400**, not shown, and the fixed wrench assembly **200** may be integrally formed with the floating wrench assembly **300**. In other examples, the fixed wrench assembly **200** may be permanently secured to drive assembly **400**. In still other examples the drive assembly **400** (FIG. 4) may be removably coupled to the fixed wrench assembly **200**, which is the configuration illustrated in FIG. 2. In addition, the fixed wrench assembly **200** can include jaws **280**, such as non-pivoting flat

jaws, that are joined to the wrench body **210** by pivots **289** that pass through at least one of the pivot holes **226**, **236**.

FIG. **3** illustrates a floating wrench **300** according to one example. The floating wrench **300** may have a similar configuration as the fixed wrench **200** or may have a different configuration. Accordingly, as illustrated in FIG. **3**, the fetter **350** is configured to be removably coupled to the first engagement arm **320** by the first coupler **360** and to the second engagement arm **330** by the second coupler **370**. The first coupler **360** in turn may include a transverse member **362** that is configured to enter a channel **322** as well as extend there-through. The first coupler **360** further includes a pivot pin **364** secured to the transverse member **362**. The pivot pin **364** is configured to engage a recess **324** in such a manner that may allow the first couple **360** to pivot relative to the first engagement arm **320** while the two are engaged.

The second coupler **370** can also be configured to be coupled to the second engagement arm **330** in such a manner that the second coupler **370** is able to rotate relative to the second engagement arm **330** while the two are engaged. The second coupler **370** in turn may include a threaded rod **372**, a swivel **374**, and a nut **376**. The threaded rod **372** may be configured to pass through a hole **332** and through the swivel **374**. The swivel **374** in turn may be sized to engage the second engagement arm **330** at the recess **334**.

The nut **376** may then be screwed on to the threaded rod **372** to thereby maintain the swivel **374** in engagement with the second engagement arm **330** at the recess **334**. As the nut **376** is further threaded onto the threaded rod **372**, the threaded rod **372** advances through the nut **376** thereby drawing the fetter **350** closer to the second engagement arm **330**.

If a rod casing or other rod is located between the fetter **350** and the wrench body **310**, drawing the fetter **350** toward the second engagement arm **330** can tension the floating wrench assembly **300** to the rod. In at least one example, the nut **376** may be configured to allow an operator to tighten the nut by hand. Such a nut **376** may include or be coupled to a thumb-wheel. In other examples, the nut **376** may include other configurations that allow hand-tightening, such as a wing nut or other type of nut.

Hand tightening the floating wrench assembly **300** may bring the floating wrench assembly **300** into engagement with a rod while allowing the rod to rotate relative to the floating wrench assembly **300** while the drive assembly **400** (FIGS. **1A-1C**, FIG. **4**) moves toward a retracted state. In this manner, the floating wrench assembly may be attached to the rod in such a manner so as to not rethread the joint as the cylinder rod of the breaking cylinder is retracted.

Any type of fetters may be used to connect the first connector and the second connector. Some examples of conventional fetters may include a leaf chain, a metal cable, a braid of metal cables, a metal strap, a belt, cast links pinned together, and so forth. The fetter **250** may be a heavy duty leaf chain, such as the Tsubaki model BL-846 with a one inch pitch and a tensile strength of about 46,200 lbs. In other examples, the fixed wrench assembly **200** and the floating wrench assembly **300** may be identical or may vary from each other in any manner.

A nut and bolt connector could then be used to tighten or loosen the fetters in order to allow a range of rod sizes to fit in the joint tool. The three and three quarter inch fetters could quickly be removed and replaced with larger or smaller fetters. For instance, the three and three quarter inch fetters may be replaced with 1 $\frac{1}{2}$ inch fetters.

FIG. **4** illustrates an exploded view of the drive assembly **400**. As previously introduced, the drive assembly **400** generally includes the cylinder **440** secured to the mount **420**. In

particular, as illustrated in FIG. **4** the mount **420** may include a body having a top clamp half **424A** and a bottom clamp half **426A** joined by a vertical support **428**. The mount **420** may also include a horizontal tab **430** secured to the bottom clamp half **426**. A mount pin **432** is secured to the horizontal tab **430** and extends away from the bottom clamp half **426A**. Opposing clamp halves **424B**, **426B** are configured to be secured to top clamp half **424A** and bottom clamp half **426A** respectively with fasteners **434**, such as bolts. In the illustrated example, the fasteners **434** are configured to extend through the opposing clamp halves **424B**, **426B** and thread into the bottom and top clamp halves **424A**, **426B**.

As the fasteners **434** are threaded into the top and bottom clamp halves **424A**, **426A**, the fasteners **434** draw the opposing clamp halves **424B**, **426B** toward the top and bottom clamp halves **424B**, **426B**. This configuration allows the mount **420** to have the cylinder **440** secured thereto. In particular, the cylinder **440** may include a housing **442**. Pins **444**, **446** may be secured to opposing sides of the housing **442**. The pins **444**, **446** may be positioned between the top and bottom clamp halves **424A**, **426A**. As the fasteners **434** are threaded as described above, the opposing clamp halves **424B**, **426B** and the top and bottom clamp halves **424B**, **426B** will be tightened against the pins **444**, **446**, thereby securing the cylinder **440** to the mount **420**.

As previously introduced, the drive assembly **400** further includes a rod **460** that is configured to be extended away from and retracted toward the cylinder **440**. In at least one example, the rod and cylinder may be a linear actuator. Any type of linear actuator may be used, such as electric, hydraulic or other types of linear actuators.

In the illustrated example, the rod **460** further includes opposing tabs **462A**, **462B** with pivot holes **464A**, **464B** defined therein. Either or both of the pivot holes **464A**, **464B** are configured to receive a pin **466**. Accordingly, the pin **466** may extend through either or both of the pivot holes **464A**, **464B**. The configuration of the mount **420** as well as the rod **460** allow the drive assembly **400** to be coupled to the fixed wrench assembly **200** as well as the floating wrench assembly **300**, which will now be described in more detail.

As previously introduced, during a joint breaking process, the fixed wrench assembly **200** may first be secured on one side of the joint. Thereafter, the drive assembly **400** may be coupled to the fixed wrench assembly **200**. In at least one example, the drive assembly **400** may be coupled to the fixed wrench assembly **200** by locating the mount **420** relative to the lever **240** and then passing the mount pin **432** at least partially through the pivot hole **242** in the lever arm **240**. The mount pin **432** may be secured to the lever arm **240** in any manner, such as by a nut, a cotter pin, a snap ring, other retention devices or combinations thereof. Accordingly, the mount **420** may couple the drive assembly **400** to the fixed wrench assembly **200**.

The drive assembly **400** can then be coupled to the floating wrench assembly **300**. In the illustrated example, the rod **460** may be coupled to the lever arm **340**. With continuing reference to FIG. **1B**, the pin **466** and tabs **462A**, **462B** may be configured to couple the rod **460** to the floating wrench **300**. In particular, the lever arm **340** of the wrench body **310** may be dimensioned to allow the wrench body **310** to be placed at least partially between the tabs **462A**, **462B**. Further, wrench body **310** may be aligned relative to the rod **460** such that the pivot holes **464A**, **464B** in the tabs **462A**, **462B** are aligned with the pivot hole **342** in the lever arm **340**.

The pin **466** may be passed through the tabs **462A**, **462B** and the lever arm **340**. The pin **466** may then be secured in any suitable manner, such as by a nut, a cotter pin, a snap ring,

other retention devices or combinations thereof. Thereafter, the floating wrench assembly 300 may be positioned relative to the joint and the fether 350 coupled to the wrench body 310 as described above to capture the rod within the floating wrench assembly 300. Once the joint tool 100 has been positioned relative to the joint, the joint tool 100 may then be used to break the joint as will now be described in more detail.

FIG. 5A illustrates a top view of the joint tool 100 in which the floating wrench assembly 300 is shown in initial engagement with the second drill rod 120B. The fether 350 can be wrapped partially around the drill rod 120B and the first coupler 360 and/or the second coupler 370 can be tightened to draw the wrench body 310 toward the second drill rod 120B. In such a configuration, the floating wrench assembly 300 is wrapped around the second drill rod 120B.

As illustrated in FIGS. 5A-5B, the lever arm 340 on the floating wrench assembly 300 may allow the rod 460 to be fully extended without hitting the first engagement arm 320 of the floating wrench assembly 300. Consequently, a lever arm 340 may be of any desired length and may be designed for optimal extension of the rod 460 and/or rotation of the floating wrench assembly 300.

In the position illustrated in FIG. 5A, the jaws 380 are brought into contact with the second drill rod 120B. Further, in the position illustrated in FIG. 5A the drive assembly 400 is in a relatively retracted position. The drive assembly 400 may then be actuated to drive the rod 460 toward the extended position.

FIG. 5B illustrates the rod 460 moving toward the extended position. As the rod 460 moves toward the extended position, the rod 460 causes the floating wrench assembly 300 to begin to rotate around the second drill rod 120B in a breaking direction. As the floating wrench assembly 300 rotates in the breaking direction, the jaws 380 rotate in such a manner that the floating wrench assembly 300 grips the second drill rod 120B.

In particular, in the example illustrated the jaws 380 may be pivoting jaws and/or may have a cam-like profile such that as the jaws move due to relative rotation in the breaking direction. One such jaw 380 is illustrated in more detail in FIG. 6A. The jaw 380 generally includes a body 382 having a first side 382A and a second side 382B. The body 382 can have any profile or shape that allows the jaw 380 to move into increasing engagement when pivoted in a breaking direction and to decreasing engagement when pivoted in a tightening direction.

In at least one example, the body 382 is configured to rotate about a pin 389 that has been passed through one or more pivot holes 384 defined in the body 310. The body 310 also includes a contact surface 386 that is configured to be brought into engagement with a rod. The pivot hole 384 may be formed at a location that is offset from the center of the body 382. The pivot hole 384 is offset toward the second side 382B of the body 382 such that a relatively larger portion of the body 382 is located toward the first side 382A than the second side 382B relative to an engaged rod such that the body 382 forms a cam. As a result, when the body 382 rotates in the breaking direction, indicated by arrow B, the first side 382A of the body 382 is located between the pivot hole 384 and the rod with which the jaw 382 is in contact.

In addition to an offset pivot hole 384, the contact surface 386 may also be shaped as desired. For example, the contact surface 386 may also have a cam-shape profile. The contact surface 386 shown has a lopsided semi-circular profile. FIG. 6B further shows that, in one exemplary embodiment, the second side 382B and part of the contact surface 386 follow the circumference of a small circle 388A from the second side

382A to point 382C. The rest of the contact surface 386 from point 382C to the first side 382A follows the circumference of a larger circle 388B. The contact surface 386 may further have teeth formed thereon to reduce or eliminate slipping of the jaw 380 as the jaw 380 grips and/or rotates the second drill rod 120B.

One example of a suitable jaw 380 may be a jaw 380 that is pivotally connected to the floating wrench assembly and that has a cam profile, as described herein. Such a pivoting jaw 380 with a cam profile may pivot towards a rod and cause the wrench to grip the rod when the wrench is moved in one direction. Conversely, such a pivoting cam profile jaw may release its grip and pivot slightly away from the rod (although it may still be in contact with the rod) when the wrench is moved in the opposite direction.

As illustrated in FIG. 6B, as the floating wrench assembly 300 rotates, engagement between the contact surface 386 and the second drill rod 120B rotates the engagement feature 382 in such a manner that the second side 382B is closer to the wrench body 310 than the first side 382A. Positioning the second side 382B closer to the wrench body 310 drives the second drill rod 120B toward the fether 350, thereby causing the floating wrench assembly 300 to grip the second drill rod 120B.

In at least one example, one or more grip limiters 500 may be associated with or more jaw. As illustrated in FIG. 5B, the grip limiter 500 may extend through the wrench body 310. In such a configuration, the grip limiter 500 may control the rotation of the jaws 380. Controlling the rotation of the jaw 380 may in control the cam effect of the jaws 380, which may in turn limit the amount of grip the floating wrench assembly 300 applies to a rod. Further, the grip limiter 500 may be used to further adjust the grip of the jaws 380 for rods of different characteristics (i.e., size, texture, hardness, etc.). Accordingly, the floating wrench assembly 300 may include pivoting jaws that help to grip the rod when the floating wrench is moved in a first direction and to slip past the rod when pivoted in a second direction that is opposite the first direction.

Jaws can be coupled to a wrench in any desired manner. Some examples of appropriate methods to connect the jaws to a wrench may include the use of one or more pins, tongues in grooves, bolts, rivets, etc. FIG. 3 illustrates one example where two pivoting jaws 380 are connected to the floating wrench assembly 300 with pins 389 that are inserted through holes 326, 336 in the wrench body 310. Thus, the pivotable jaws 380 may be easily removed, replaced, reoriented, and so forth.

Pivoting engagement features may have various configurations. For example FIG. 6C illustrates a pivoting, jaw 380' that includes a non-cammed contact surface 386' with teeth formed thereon. The teeth may have an angle relative to a nominal flat surface of about 30 degrees. FIG. 6D-6F show jaws 380ⁱⁱ-380^{iv} with various shapes and having a pivot holes 384 located in various positions with contact surfaces of various shapes. To this point, pivoting jaws have been described. These jaws have been described in connection with a floating wrench assembly 300. In other examples, non-pivoting jaws may be provided.

FIG. 7 illustrates that a flat profile jaw 380^v that can be connected to a fixed wrench assembly 200 (FIG. 2) through the lower center of the jaw 380^v and has an inner surface 390 that is flat. Such a configuration may reduce or prevent rotation of the jaw 380^v due to contact between the inner surface 390 and a wrench body, such as the wrench body 310 (FIG. 3).

Pivoting and/or non-pivoting jaws may be provided in any combination with the floating wrench assembly 300 and/or the fixed wrench assembly 200. The contact surfaces and/or

inner surfaces of any fixed and/or pivotable jaw(s) that comes in contact with a drill rod may have any desired texture and/or shapes. Thus, the jaws may be designed to increase friction or to “bite” a rod, as desired. By way of illustration, the contact surface of the jaws may have teeth, it may be smooth, it may be rough, it may be crosshatched, it may be knurled, it may be diamond coated, it may contain carbide inserts, and so forth. In some embodiments, one or both of the wrenches may contain jaws. The two wrenches need not have the same type or number of jaws.

In at least one example, fixed jaws may optionally be formed as part of a wrench assembly. Additionally, fixed jaws may be fastened in, on, or to a wrench assembly in any desired manner. Some ways of attachment may include one or more pins, bolts, rivets, epoxies, welds, etc. Further, jaws may be fastened to a wrench assembly, such as the fixed wrench assembly **200**, by placing the fixed jaw in a groove defined in the fixed wrench assembly **200**.

Once the fixed jaw is set in the groove, a jaw pin may be placed through jaw holes in the wrench body **210** the fixed jaw. Additionally, a retaining ring may be placed in a groove in the wrench body, to prevent the jaw pin from becoming dislodged. The jaw pin may therefore allow the fixed jaw to be easily removed and/or replaced.

Fixed jaws may also have any profile known in the art. For example, the fixed jaws may have a flat profile, a cam profile, a “V” profile, or an elliptical profile. The proximal end of both pivotable and fixed jaws may have any desired shape and may be connected to a wrench in any desired orientation. In at least one example, the different shapes of a gripping and orientation may affect whether a jaw is fixed or whether it is pivotable. Moreover, for jaws that do pivot, the jaws’ orientation and shape of the proximal end may affect the extent to which a jaw may pivot in any given direction.

As introduced, contact surfaces may have teeth formed thereon. The teeth may point in any direction(s) and may be of any desired size(s), shape(s), or type(s). For example, FIGS. **6A** and **6C** illustrate contact surface with triangular teeth. In those Figures, the three angles of the each triangular tooth may be approximately thirty degrees, ninety degrees, and sixty degrees, moving left to right. In such an example, the peak of the triangular teeth, or the 90 degree angle, may grip or bite into a drill rod, especially when the fetter of the wrench corresponding wrench is moving into gripping contact with a rod while the associated wrench assembly is rotated in a breaking direction and to allow the rod to slip over the teeth as the wrench assembly is rotated in the tightening direction.

In some instances, the pivotable jaws may be biased by a spring. A spring may bias the pivoting jaw in a desired direction to enhance or reduce grip of the jaws as desired. The joint tool may use any type of breaking cylinder to force a wrench in either direction. Some suitable examples of breaking cylinders may include any type of linear actuator, hydraulic cylinder, pneumatic cylinder, solenoid, and the like. The breaking cylinder may have any desired feature that allows or helps it perform this breaking function. For example a breaking cylinder may be any size, may have any desired strength, may be uni- or bi-directional, may have a cylinder rod of any desired length, and the like. Additionally, while the breaking cylinder may comprise a breaking cylinder barrel, a breaker mount, and a cylinder rod, it need not have each of these elements provided it can function in this manner.

In at least one example, a floating wrench assembly and a fixed wrench assembly may be similar or substantially the same. In at least one of such examples, the floating wrench assembly and the fixed wrench assembly may be similar, even if they are used in the same or different orientations. In other

examples, the wrenches assemblies may be different in one or several aspects. Further, the floating wrench and the fixed wrench may have any desired difference.

Another example of a suitable jaw may be a ratchetable wheel. Any known ratchetable wheel may be used as a jaw. Such a wheel may spin as a wrench moves around the rod in one direction and may not move as the wrench moves around the rod in the opposite direction. Additionally, such a ratchetable wheel may be bi-directional, or it may be adjusted from ratcheting in one direction to ratcheting in the opposite direction.

Another example of a suitable pivotable jaw may include any type of jaw that slides on and/or in the wrench as the wrench turns in one direction. Such a jaw may slide as a wrench is moved in one direction, and thereby allow the wrench to move across the drill rod without threading or unthreading the joint. However, when a wrench with one or more such slidable jaws is turned in the opposite direction, the slidable jaws may slide back to their original position and may grip the rod so that the rod moves along with the wrench.

In at least one example, the joint tool **100** may be modular so that the joint tool may be regularly disassembled into multiple components and easily reassembled. Thus, the joint tool may be manually portable. In such an example, the joint tool may be broken into any desired components as well as any number of desired components. For example, in some examples, the joint tool may be broken into three pieces as described above. In other examples, the joint tool may be broke into more or less pieces as desired. Such configurations may allow the joint tool to be manually assembled such that assembly can be accomplished without auxiliary equipment to move it into position as desired. In fact, in some examples the joint tool may be so light and portable that just one worker could transport, install, and use the joint tool. In this way, a worker may be able to take the joint tool to a desired joint, instead of trying to raise or lower the drill rod to position the joint for the tool. Thus, the joint tool may be versatile and be used in situations that may normally require hand wrenches or movement of the drill rod(s) to auxiliary breaking equipment.

Each of the aforementioned components of the joint tool may be made of any desired material or combination of materials. For example, the wrench bodies, the fetter, the jaws, the cylinder rod, and so forth may be made of any desired metal, ceramic, steels, and/or the like. For instance, some examples of suitable metals may include steel, iron, titanium, brass, bronze, and/or aluminum. Some examples of suitable ceramic-containing materials may include oxides, borides, carbides, and nitrides of compositions such as aluminum, boron, zirconium, beryllium, silicon, titanium, tungsten, and iron. Additionally, some examples of ceramic matrix composite compositions that may be used for construction of the aforementioned components may include tungsten carbide, alumina, silicon carbide, zirconium carbide, aluminum nitride, aluminum carbide, and boron carbide.

Also, the breaking cylinder may be powered through any conventional system, such as hydraulic power. For example, a breaking cylinder could be powered by the auxiliary function of a drill power pack, by a power pack, by hydraulic power from an unsecured function, by a diesel engine from a driven power pack, by an electric motor from a driven power pack, by an air/hydraulic pump, and so forth. In some embodiments, a hydraulic breaking cylinder may be powered by a modified hydraulic power pack from a truck or all-terrain-vehicle (“ATV”) snow plow assembly. In such embodiments, any plow hydraulic power pack with any modification(s) may

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be used to power the breaking cylinder of the joint tool. Consequently, the joint tool may be used anywhere that is truck or ATV accessible.

The joint tool may be used for many purposes. For example, as described above, the joint tool may be used to break joints and/or unthread rod sections. In fact, the joint tool may be used in combination with any other known tool (e.g., hand wrenches) to break and/or unthread joints.

The joint tool may also be operated in any position. For example, the joint tool may be used to break/unthread joints that are in a vertical position, as depicted in FIG. 1. In another example, the joint tool may be used to break/unthread joints that are in a horizontal position. Indeed, the joint tool may be used on rods that are in any orientation.

The joint tool as described above is used primarily to break and/or unthread a joint. To make and/or thread a joint, the components of the tools can re-configured to allow the joint tool to make a joint and/or thread sections of drill rod together. In some embodiments, the jaws may be re-configured to switch the joint tool from a breaking/unthreading mode to a making/threading mode by making a mirror image of the upper and lower wrench body of the casing breaker.

In addition to any variation previously mentioned, the joint tool may be modified in any manner and may have any desired variation. In some variations, the joint tool may have multiple breaking cylinders. One breaking cylinder may be used for making joints and the other breaking cylinder may be used for breaking joints. Additionally, where multiple breaking cylinders are used, one may be used as a backup if the first jams or is damaged. In other variations, the joint tool could have a plurality of wrenches on a side of a joint, thereby increasing the number of wrenches in a single joint tool to 3 (or more).

In addition to any previously indicated modification, numerous other variations and alternative arrangements may be devised by those skilled in the art without departing from the spirit and scope of the invention, and appended claims are intended to cover such modifications and arrangements. Thus, while the invention has been described above with particularity and detail in connection with what is presently deemed to be the most practical and preferred aspects of the invention, it will be apparent to those of ordinary skill in the art that numerous modifications, including, but not limited to, form, function, manner of operation and use may be made without departing from the principles and concepts set forth herein. Also, as used herein, examples are meant to be illustrative only and should not be construed to be limiting in any manner.

What is claimed is:

1. A joint tool, comprising:

- a first wrench assembly configured to be placed in gripping contact with a first rod;
- a second wrench assembly including at least two jaws configured to selectively grip a second rod, said second wrench assembly being adapted to rotate the second rod relative to the first rod when said second wrench assembly is rotated in a first direction, said second wrench assembly being further adapted to rotate relative to the second rod when said second wrench assembly is rotated in a second direction, said second wrench comprising an engagement arm, wherein said at least two jaws are pivotally coupled to said engagement arm,
- a fetter adapted to be adjustably coupled at both ends thereof to said engagement arm, and
- an arcuate lever arm coupled to said engagement arm between said at least two jaws; and
- a drive assembly operatively associated with said first wrench assembly and said second wrench assembly,

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said drive assembly being configured to rotate said second wrench assembly in the first direction and the second direction, and wherein said drive assembly is pivotally coupled to said lever arm.

2. The tool of claim 1, wherein said first wrench assembly and said second wrench assembly are each pivotally coupled to the drive assembly.

3. The tool of claim 1, wherein said first wrench assembly includes at least one jaw, said at least one jaw of said first wrench assembly being configured to grip the first rod when said first wrench assembly is rotated in a first direction and to slip over the first rod when said first wrench assembly is rotated in a second direction.

4. The tool of claim 3, wherein said at least one jaw of said first wrench assembly is a pivoting jaw.

5. The tool of claim 4, wherein said pivoting jaw of said first wrench includes a body having a first side and a second side and further comprising a pivot hole defined in said body, said pivot hole being offset from a center of said body toward said first side.

6. The tool of claim 4, wherein said pivoting jaw of said first wrench includes a contact surface configured to contact the first rod, said contact surface having a cam-profile surface.

7. The tool of claim 1, wherein said first wrench assembly is a fixed wrench assembly and said second wrench assembly is a floating wrench assembly, said floating wrench assembly being configured to rotate relative to said fixed wrench assembly in said first direction to break a joint.

8. The tool of claim 1, wherein said drive assembly is adapted to maintain said first wrench assembly in a generally stationary position while rotating said second wrench assembly in the first direction and the second direction.

9. A joint tool for use in manipulating the joints of connected drill rods of a drill string, comprising:

- a first wrench assembly adapted to engage a first rod;
- a second wrench assembly adapted to engage a second rod, said second wrench assembly being adapted to rotate in a first direction relative to said first wrench assembly and rotate in a second direction relative to said first wrench assembly, said second wrench comprising an engagement arm,
- at least one jaw pivotally coupled to said engagement arm,
- a fetter adapted to be adjustably coupled at both ends thereof to said engagement arm, and
- a lever arm coupled to said engagement arm; and
- a drive assembly operatively associated with said first wrench assembly and said second wrench assembly, said drive assembly adapted to rotate said second wrench assembly in said first direction relative to said first wrench assembly and said second direction relative to said first wrench assembly to manipulate a joint between the first and second rods, and wherein said drive assembly comprises a cylinder, a rod movably coupled to said cylinder, said rod being coupled at a first end thereof to said second wrench assembly, and a mount coupled to a first end of said cylinder, said mount pivotally coupling said first wrench assembly to said second wrench assembly at a first pivot point, wherein said first pivot point is positioned between said first end of said cylinder and said first end of said rod.
- 10. The tool of claim 9, wherein said second wrench assembly is adapted to grippingly engage the second rod when said second wrench assembly is rotated in the first direction so as to cause axial rotation of the second rod in the first direction.
- 11. The tool of claim 10, wherein said second wrench assembly is adapted to slip around the second rod when said

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second wrench assembly is rotated in the second direction such that said second wrench assembly rotates relative to the second rod without causing substantial axial rotation of the second rod in the second direction.

12. The tool of claim 11, wherein said at least one jaw facilitate the gripping engagement between said second wrench assembly and the second rod when said second wrench assembly is rotated in the first direction, and wherein said at least one jaw facilitate the slipping of said second wrench assembly around the second rod when said second wrench assembly is rotated in the second direction.

13. The tool of claim 12, wherein said at least one jaw includes a body having a first side and a second side and further comprising a pivot hole defined in the body, said pivot hole being offset from a center of said body toward said first side.

14. The tool of claim 9, wherein said first wrench assembly is a fixed wrench assembly and said second wrench assembly is a floating wrench assembly, said floating wrench assembly being configured to rotate the second rod relative to said fixed wrench assembly and the first rod in the first direction to break a joint between the first rod and the second rod.

15. The tool of claim 9, wherein movement of said drive assembly rod relative to said cylinder causes rotation of said second wrench assembly relative to said first wrench assembly.

16. A joint tool for use in manipulating a joint between connected rods, the joint tool comprising:

a fixed wrench assembly configured to be grippingly secured to a first rod to limit axially rotation of the first rod relative to said fixed wrench assembly during manipulation of the joint;

a floating wrench assembly including at least one jaw configured to selectively engage a second rod, said floating wrench assembly adapted to axially rotate the second rod when said floating wrench assembly is rotated in a first direction, said at least one jaw further configured to disengage the second rod when said floating wrench assembly is rotated in a second direction, the second direction being different than the first direction; and

a drive assembly coupled to said fixed wrench assembly and said floating wrench assembly, wherein said drive assembly is adapted to move said floating wrench assembly in the first direction and the second direction, wherein said drive assembly comprises a cylinder, a rod movably coupled to said cylinder, said rod being coupled at a first end thereof to said floating wrench assembly, and a selectively removable mount coupled to a first end of said cylinder, said mount pivotally coupling said fixed wrench assembly to said floating wrench assembly at a first pivot point, wherein said first pivot point is positioned between said first end of said cylinder and said first end of said rod.

17. The tool of claim 16, wherein extension of said drive assembly rod relative to said cylinder moves said floating wrench assembly in the first direction, thereby causing said at least one jaw to grippingly engage and rotate the second rod in the first direction, and wherein retraction of said drive assembly rod relative to said cylinder moves said floating wrench assembly in the second direction and allows said floating wrench assembly to move relative to the second rod.

18. The tool of claim 16, wherein said fixed wrench assembly is coupled to said mount to substantially maintain the position of said fixed wrench relative to said floating wrench assembly when said drive assembly rod is extended from or retracted into said cylinder.

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19. The tool of claim 16, wherein said fixed wrench assembly includes a substantially non-pivoting jaw to facilitate gripping engagement of said fixed wrench assembly to the first rod.

20. A joint tool for use in manipulating a joint between a rod and a second rod, the joint tool comprising:

a fixed wrench assembly having at least one jaw, wherein said at least one jaw is configured to facilitate secure engagement of said fixed wrench assembly to the first rod to substantially prevent axially rotation of said fixed wrench assembly relative to the first rod during manipulation of the joint;

a floating wrench assembly adapted to move in a first direction and a second direction relative to said fixed wrench assembly, said floating wrench assembly having at least two pivoting jaws configured to selectively pivot into and out of gripping engagement with the second rod, wherein each of said at least two pivoting jaws pivots into gripping engagement with the second rod when said floating wrench assembly is moved in the first direction, thereby enabling said floating wrench assembly to grip and axially rotate the second rod relative to the first rod when said floating wrench assembly is moved in the first direction, and wherein each of said at least two pivoting jaws pivots out of gripping engagement with the second rod when said floating wrench assembly is moved in the second direction, thereby allowing said floating wrench assembly to move relative to the second rod, said floating wrench assembly comprising

an engagement arm, wherein said at least two pivoting jaws are pivotally coupled to said engagement arm, and

an arcuate lever arm coupled to said engagement arm between said at least two pivoting jaws; and

a drive assembly coupled to said fixed wrench assembly and said floating wrench assembly, wherein said drive assembly is adapted to move said floating wrench assembly in the first direction and the second direction relative to said fixed wrench assembly, wherein said drive assembly comprises a selectively removable mount for pivotally coupling said fixed wrench assembly to said floating wrench assembly, wherein said mount is capable of pivoting with respect to said fixed wrench assembly.

21. The tool of claim 20, wherein said fixed wrench assembly and said floating wrench assembly are spaced apart such that the joint connecting the first rod and the second rod is disposed between said fixed wrench assembly and said floating wrench assembly.

22. The tool of claim 20, wherein said drive assembly comprises a cylinder secured to said mount, and a drive assembly rod associated with said cylinder, wherein said drive assembly rod is adapted to be extended out of and retracted into said cylinder.

23. The tool of claim 22, wherein said cylinder is pivotally secured to said mount.

24. The tool of claim 22, wherein said floating wrench assembly is coupled to an end of said drive assembly rod such that extension and retraction of said cylinder causes movement of said floating wrench assembly in the first direction and the second direction, respectively.

25. The tool of claim 20, wherein at least one of said fixed wrench assembly and said floating wrench assembly is selectively adjustable to facilitate engagement with rods of varying sizes.

UNITED STATES PATENT AND TRADEMARK OFFICE
CERTIFICATE OF CORRECTION

PATENT NO. : 7,997,166 B2
APPLICATION NO. : 12/138297
DATED : August 16, 2011
INVENTOR(S) : Lauzon et al.

Page 1 of 2

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Column 1

Line 12, change “to apparatus” to --to an apparatus--

Column 3

Line 55, change “illustrates” to --illustrate--

Column 6

Line 8, change “such on” to --such as on--

Line 52, change “nut be sized” to --nut can be sized--

Column 7

Line 15, change “first couple 360” to --first coupler 360--

Column 8

Line 5, change “half 426” to --half 426A--

Line 12, change “424A, 426B” to --424A, 426A--

Line 23, change “424B, 426B” to --424A, 426A--

Column 9

Line 49, change both instances of “body 310” to --body 382--

Line 60, change “jaw 382” to --jaw 380--

Column 10

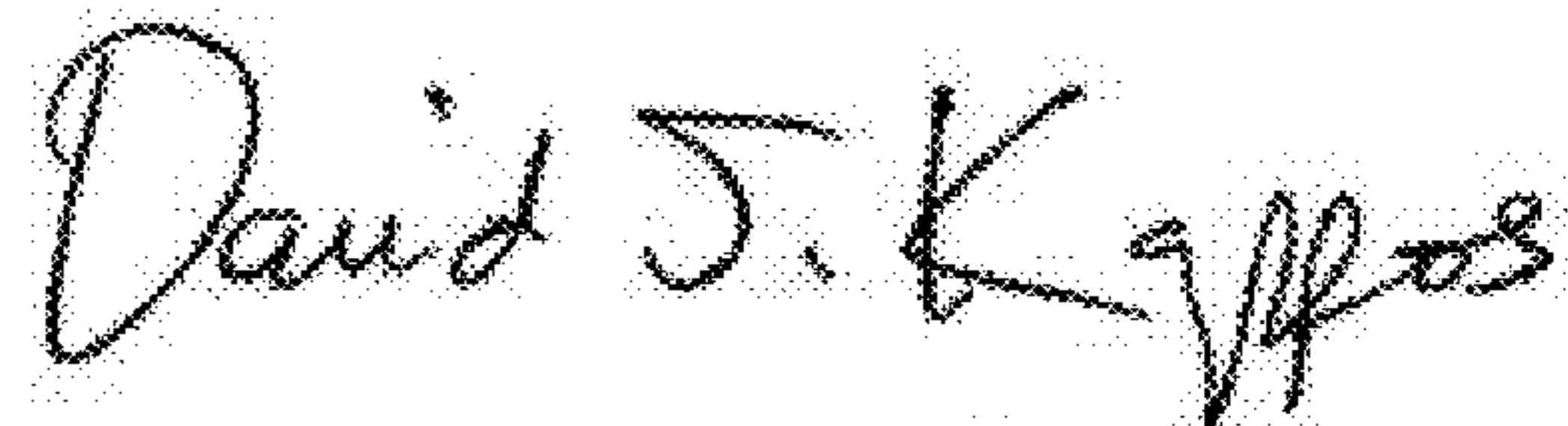
Line 26, change “with or more jaw” to --with one or more jaws--

Line 30, remove [in]

Line 52, change “FIG. 6D-6F” to --FIGS. 6D-6F--

Line 53, change “having a pivot holes” to --having a pivot hole--

Signed and Sealed this
Twenty-second Day of November, 2011



David J. Kappos
Director of the United States Patent and Trademark Office

Column 11

Line 3, change “shapes” to --shape--

Line 43, after “the fetter of the” remove [wrench]

Column 12

Line 1, change “wrenches assemblies” to --wrench assemblies--

Line 30, change “broke” to --broken--

Column 13

Line 17, change “can re-configured” to --can be re-configured--

Line 59, change “comprising” to --comprising:--

Column 14

Line 40, change “comprising” to --comprising:--

Column 15

Line 6, change “facilitate” to --facilitates--

Line 9, change “facilitate” to --facilitates--

Column 16

Lines 27-28, change “comprising” to --comprising:--